

TITLE OF INVENTION

**Seat Heating and Cooling System**

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable

5 STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR  
DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

1. Field of Invention

10 [0003] This invention pertains to a system that selectively heats and cools a seat. More particularly, this invention pertains to a seat heating and cooling system in which the heat transfer fluid is a liquid and the seat is an exposed seat, such as found on a motorcycle, a tractor, or industrial equipment.

2. Description of the Related Art

15 [0004] Drivers and passengers of automobiles and trucks have access to air conditioning systems within the vehicle and, in many cases, have the luxury of heated and/or cooled seats. Temperature controlled seats provide increased comfort.

20 [0005] The prior art discloses several different design approaches to the problem of providing an inexpensive, effective and long lasting heated and/or cooled seat. One approach, disclosed in Patent Number 2,722,266, entitled "Refrigerated Seat and/or Back Rest," issued to Kersten on November 1, 1955, is to circulate a refrigerant through a coil in the seat, where the refrigerant can expand and cool the seat and any occupant.

25 [0006] Another, similar approach is disclosed Patent Number 6,254,179, entitled "Air Conditionable Vehicle Seat," issued to Kortum, et al., on July 3, 2001.

The Kortum patent discloses using the heating and/or cooling system existing in a vehicle on the primary side of a heat exchanger to heat and/or cool water on the secondary side, which passes through coils embedded in the vehicle seat. An advantage of the system cited by Kortum is that the water passing through the seat  
5 is preferably pure and does not contain any harmful additives. Another cited advantage is the utilization of the heating and/or cooling system integrated in the vehicle.

[0007] Another approach to seat conditioning is evidenced by various patents that disclose forcing air through the seat surface, thereby heating or  
10 cooling the occupant by convection. An example of this approach is disclosed in Patent Number 6,223,539, entitled "Thermoelectric Heat Exchanger," issued to Bell on May 1, 2001, which discloses a fan with a thermoelectric device, a Peltier device, integrated in its annulus. The Peltier device selectively heats and cools the air that is being pushed through the fan and into a vehicle seat, where it is  
15 discharged through a permeable surface of the seat.

[0008] A similar approach is disclosed in Patent Number 5,117,638, entitled "Selectively Cooled or Heated Seat Construction and Apparatus for Providing Temperature Conditioned Fluid and Method Therefor," issued to Feher on June 2, 1992, which discloses a seat in which convection of air is used to heat and cool the seat occupant. Air is the temperature transfer fluid for a main heat exchanger and a liquid, such as a glycol/water mixture, is the fluid for an auxiliary heat  
20 exchanger. The energy from the auxiliary heat exchanger, which is transmitted through the liquid, is used to condition the air from the main heat exchanger discharged from the seat back. This system has the advantage of further  
25 conditioning the air that is being discharged at a distance from the original heat source.

[0009] Another similar approach, is disclosed in Patent Number 6,510,696, entitled "Thermoelectric Air-Condition Apparatus," issued to Guttman, et al., on January 28, 2003. This patent discloses a Peltier device as a source that  
30 selectively heats or cools air. The conditioned air is forced, not through the

motorcycle seat, but through a bodysuit and a helmet, thereby supplying conditioned air around the upper body and head of the motorcyclist.

5 [0010] Motorcyclists and drivers of vehicles that do not have an enclosed cabin, such as tractors, forklifts, and boats, do not have access to a cabin with an air conditioning system. It is desirable to provide a heating and cooling source to operators of such equipment. This equipment must operate with the operator subject to wind and other environmental conditions.

#### BRIEF SUMMARY OF THE INVENTION

10 [0011] According to one embodiment of the present invention, a seat heating and cooling system is provided. A thermoelectric device selectively heats and cools a liquid that is pumped through a seat heat exchanger, coils in one embodiment, a bladder in another. The liquid exchanges heat through the seat by conduction. In one embodiment, the thermoelectric device heats a liquid in a heat exchanger. The liquid is pumped through a seat heat exchanger that is, in one embodiment, inside 15 the seat, thereby warming the seat surface by conduction. In another embodiment, the thermoelectric device cools the liquid, which consequently cools the seat.

20 [0012] In one embodiment, the liquid is a glycol mixture with antifungal and antibacterial properties. The liquid has a freeze point less than the expected ambient temperature expected for its service. In one embodiment, the liquid has a freeze point less than zero degrees Fahrenheit. In one embodiment, the system 25 includes a temperature controller that prevents overheating of the liquid, thereby ensuring that the seat occupant is never exposed to a harmful temperature.

25 [0013] In one embodiment, a heat sink is thermally coupled to the thermoelectric device. The heat sink has air forced through it by a fan. In another embodiment, a second heat exchanger is in fluid communication with a radiator and transfers heat to/from the thermoelectric devices at the opposite end of the devices from the seat loop.

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0014] The above-mentioned features of the invention will become more clearly understood from the following detailed description of the invention read together with the drawings in which:

- 5 Figure 1 is a pictorial view of a seat heating and cooling system;
- Figure 2 is a top view of the main heat exchanger;
- Figure 3 is a cross-sectional view of the main heat exchanger;
- Figure 4 is an exploded view of the main heat exchanger;
- Figure 5 is a cross-sectional view of the main heat exchanger;
- 10 Figure 6 is a perspective view of the main heat exchanger assembly;
- Figure 7 is a cross-sectional view of a portion of the seat;
- Figure 8 is a block diagram of the electrical connections for the system;
- Figure 9 is a schematic diagram of the electrical connections for one embodiment of the system;
- 15 Figure 10 is a schematic diagram of the electrical connections for a system with temperature control;
- Figure 11 is a pictorial view of another embodiment of a seat heating and cooling system;
- Figure 12 is a top view of one embodiment of a seat cooler;
- 20 Figure 13 is a cross-sectional view of the embodiment of a seat cooler of Figure 12;
- Figure 14 is an exploded view of one embodiment of a heat exchanger;
- Figure 15 is a perspective view of one embodiment of a seat side reservoir;

Figure 16 is a perspective view of one embodiment of a seat side channel plate;

Figure 17 is a perspective view of one embodiment of a opposing side channel plate;

5 Figure 18 is a perspective view of one embodiment of a heat sink plate; and

Figure 19 is a block diagram of another embodiment of the system.

#### DETAILED DESCRIPTION OF THE INVENTION

[0015] A seat heating and cooling system is disclosed. The system provides temperature conditioning of the seat, that is, the temperature of the seat is selectively raised or lowered. The system is suitable for use on vehicles in which the operator is exposed to the environment or in which the operator is not in an air conditioned environment.

[0016] Figure 1 pictorially illustrates one embodiment of the seat heating and cooling system **10** adapted for use on a motorcycle. A motorcycle seat **102** has a coil **104** through which a heat transfer liquid is circulated by a pump **106**. The liquid is pumped into a heat exchanger **108**, which is part of a heat exchanger assembly **110**. The heat exchanger assembly **110** includes the heat exchanger **108**, a pair of thermoelectric devices **112a** and **112b** attached to opposite sides of the heat exchanger **108**, a pair of heat sinks **114a** and **114b**, and a pair of fans **116a** and **116b**. The inboard surface of the thermoelectric devices **112a** and **112b** are thermally coupled to the heat exchanger **108**. The outboard surface of the thermoelectric devices **112a** and **112b** are thermally coupled to heat sinks **114a** and **114b**, through which air **118a** and **118b** is forced by fans **116a** and **116b**.

[0017] The coil **104**, the pump **106**, and the heat exchanger assembly **110** are interconnected with tubing **122**, **128**, and **132**. In one embodiment, the pump **106** and the heat exchanger assembly **110** are remote to the seat **102**, and the tubing **122** and **128** have sealing quick disconnects **124** and **126** that allow the coil **104** in the seat **102** to be isolated from the remainder of the system **10**. In one

embodiment, the inlet to the pump **106** has an air separator to trap any air within the system **10**.

[0018] The thermoelectric devices **112a** and **112b**, in one embodiment, are Peltier devices, which are devices that selectively cool and heat opposing surfaces 5 based on the polarity of a direct current voltage applied to the device. With the polarity of the voltage applied to the thermoelectric devices **112a** and **112b** such that the temperature of the heat exchanger **108** is higher than ambient, and the heat transfer liquid is heated. The heated liquid is forced through the coil **104** in the seat **102**, thereby warming the body surface of the occupant by conduction. 10 The cooled liquid is pumped from the seat **102**, through the pump **106**, and into the heat exchanger **108**, where the cycle is repeated. Those skilled in the art will recognize that the pump **106** can be located on either side of the heat exchanger **108** without departing from the spirit and scope of the present invention.

[0019] By reversing the polarity, the temperature of the heat exchanger **108** 15 is made lower than ambient, and the heat transfer liquid is cooled. The cooled liquid is forced through the coil **104** in the seat **102**, thereby cooling the body surface of the occupant by conduction. The liquid warmed by the occupant is pumped from the seat **102**, through the pump **106**, and into the heat exchanger **108**, where the cycle is repeated.

[0020] Figure 2 illustrates the top view of the heat exchanger **108**. The top 20 of the heat exchanger **108** has an inlet port **202** and an outlet port **204**. In the illustrated embodiment, the two ports **202** and **204** are the same size, that is, they have the same diameter. In another embodiment, the outlet port **204** has a larger diameter than the inlet port **202**, thereby reducing the backpressure of the outlet 25 port **204**.

[0021] Figure 3 is a cross-sectional view of the heat exchanger **108**. The 30 heat exchanger **108** includes a body **304** and an end piece **302**. In one embodiment, the end piece **302** is welded to the body **304**, thereby forming a liquid-tight seal between the body **304** and the end piece **302**. In another embodiment, the end piece **302** is attached to the body **304** with an adhesive or epoxy compound, thereby forming a liquid-tight seal. Inside the heat exchanger

108 are a series of ribs 306a, 306b, 306c, 306d, and 306e. These ribs 306a, 306b, 306c, 306d, and 306e serve two purposes, the first being to increase the surface area of the heat exchanger 108 exposed to the liquid. The second is to secure the baffle plate 402, illustrated in Figure 4. Those skilled in the art will 5 recognize that the number and size of the ribs can vary without departing from the spirit and scope of the present invention.

[0022] The heat exchanger 108, in one embodiment, is fabricated of aluminum, which is corrosion-resistant to the heat transfer liquid. In another embodiment, the heat exchanger 108 is fabricated of a material having a high heat 10 transfer coefficient in order to maximize the transfer of heat between the heat transfer liquid and the thermoelectric devices 112a and 112b.

[0023] Figure 4 illustrates the heat exchanger 108 in an exploded view. The end piece 302 is a top plate that covers the opening in the body 304. The baffle plate 402 is positioned inside the body 304 and secured in place between ribs 15 306b, 306c, 406b, 406c between the inlet and outlet ports 202 and 204. The baffle plate 402 has an opening 404 at the end opposite the ports 202 and 204, thereby allowing the fluid to flow from the inlet port 202, along the ribs 306a and 406a, through the baffle plate opening 404, along the ribs 306d, 306e, 406d, 406e, and through the outlet port 204. In one embodiment, the baffle plate 402 is 20 fabricated of the same material as the body 108. The purpose of the baffle plate 402 is to direct the flow of the liquid over the greatest possible surface area of the heat exchanger 108.

[0024] In another embodiment, the heat exchanger 108 is formed of two halves with the split in the portion of the heat exchanger 108 between the two 25 thermoelectric devices 112a and 112b. In this embodiment, the heat exchanger 108 is formed from two metal slabs that have the ribs 306 machined in one slab and the ribs 406 machined in the other. The two halves are mated and the ports 202 and 204 are drilled through one end. The fastening means that clamps the thermoelectric devices 112a and 112b to the heat exchanger 108 also secures the 30 two halves together. In another embodiment, sealing means, such as an adhesive or O-ring, are employed to ensure that the heat exchanger 108 is fluid tight.

[0025] Figure 5 illustrates a top view of the heat exchanger body **304**. The ribs, or fins, **306** and **406** have the function of increasing the surface area of the inside of the heat exchanger **108**, thereby increasing the heat transfer between the outside surface of the heat exchanger **108** and the liquid inside the heat exchanger **108**. The ribs, or fins, **306** and **406** also function to secure the baffle plate **402** in position inside the heat exchanger **108**. In one embodiment, the number of ribs **306** and **406** is greater than the ten illustrated, and multiple baffle plates **402** are used with the openings **404** offset to direct the fluid flow over a greater inside surface area of the heat exchanger **108**.

[0026] Figure 6 illustrates the heat exchanger assembly **110**. The seat side fluid loop heat exchanger **108** is sandwiched between two thermoelectric devices **112a** and **112b**. The opposite sides of each of the thermoelectric devices **112a** and **112b** are each thermally attached to another heat exchanger that includes a heat sink **114a** and **114b**. The heat sinks **114a** and **114b** are heated or cooled by fans **116a** and **116b**, which force air over the fins **602a** and **602b** of the heat sinks **114a** and **114b**. The fins **602a** and **602b** are made of a thin sheets of material with high thermal conductivity, and a fan blade **616** in each fan **116a** and **116b** forces ambient air to flow between and through the fins **602a** and **602b**.

[0027] In one embodiment, the thermoelectric devices **112a** and **112b** are Peltier devices that have one surface that increases in temperature and a second surface that decreases in temperature upon the application of a direct current voltage. The two surfaces of the thermoelectric devices **112a** and **112b** that are subject to temperature changes have a large surface area, and one surface is thermally bonded to the heat exchanger **108** and the other is thermally bonded to the heat sinks **114a** and **114b**. In one embodiment, fasteners are used to draw the two heat sinks **114a** and **114b** together, thereby ensuring both a mechanical and thermal connection between the heat sinks **114a** and **114b**, the thermoelectric devices **112a** and **112b**, and the heat exchanger **108**. In one embodiment, the fasteners are four turnbuckles, each one located at each corner of the heat sinks **114a** and **114b**, and the turnbuckles do not pass through the thermoelectric devices **112a** and **112b** or the heat exchanger **108**.

[0028] In one embodiment, the thermoelectric devices **112a** and **112b** have heat transfer surfaces that are approximately two inches square and the heat exchanger assembly **110** is approximately seven inches wide, measured from fan **116a** to fan **616b**. In one embodiment, the heat exchanger assembly **110** and the pump **106** are mounted at a location away from the seat and are enclosed in a housing that provides protection from the environment, but still allows air flow through the fans **116a** and **116b** and the heat sinks **114a** and **114b**. The housing, in one embodiment, is incorporated in a bag or other enclosure secured to a travel rack attached to the rear fender of a motorcycle.

[0029] In order to minimize the energy loss for the remote installation of the heat exchanger assembly **110**, the tubing **122**, **128**, and **132** between the seat **102**, the pump **106**, and the heat exchanger assembly **110** is insulated. In one embodiment, the tubing **122**, **128**, and **132** is covered with an insulator that is flexible, but with low thermal conductivity, for example, a closed cell neoprene. The portions of the tubing **122** and **128** extending from the coil **104** pass through the seat, which includes a material with low thermal conductivity and serves as insulation. The quick disconnects **124** and **126** are located just outside the seat **102**.

[0030] The portions of the heat exchanger **108** that are not attached to the thermoelectric devices **112a** and **112b** are insulated to minimize undesired energy transfer between the heat exchanger **108** and the environment. In one embodiment, the heat exchanger **108** insulation is a ceramic coating having low thermal conductivity. In another embodiment, the insulation is an insulator that has low thermal conductivity, for example, closed cell neoprene.

[0031] Figure 7 illustrates a cross-section of a portion of the seat **102** and the coil **104**. In one embodiment, the seat **102** has a foam layer **702** shaped to the desired contour of the seat **102**. In the illustrated embodiment, the coil **104** includes tubing arranged in a series of strips **104a**, **104b**, **104c**, and **104d** that are imbedded in the foam layer **702**. Above the strips **104a**, **104b**, **104c**, and **104d** is an upper layer **704** of a material. The upper layer **704** serves to provide a smooth surface for the seat occupant and also has a high thermal conductivity to allow

heat conduction through the upper layer **704**, for example muslin. The foam layer **702** and the upper layer **704** are encased in a cover that is waterproof, for example, vinyl or plastic. The waterproof cover is useful for motorcycles and other vehicles that do not have an enclosed cabin to protect the seat from the environment, in particular, rain.

5 [0032] The primary means for heat transfer is conduction between the seat **102** and the seat's occupant. The coil **104** selectively heats and cools the seat **102** by heat transfer between the liquid in the coil **104** and the seat **102**. With a heated seat **102**, the heat is conducted from the seat **102** to the occupant, and 10 with a cooled seat, the heat is conducted from the occupant to the seat **102**. Because an unprotected seat, and its occupant, is exposed to the environment, which includes wind, whether induced by nature or the speed of the vehicle, convective heat transfer is inefficient and unsuitable. Convection is the transfer of heat by the absorption of heat by a fluid at one point followed by motion of the 15 fluid and rejection of the heat at another point. The seat heaters that operate with convective heat transfer use air as the fluid that transfers heat between the heating/cooling source and the occupant. An exposed seat subject to wind tends to reduce the amount of air that flows between the heating/cooling source and the occupant.

20 [0033] The liquid used for the heat transfer fluid requires certain properties because of the environment the system **10** operates. An unprotected seat is exposed to the range of temperatures in which it is stored and operated. For example, a motorcycle stored outside or in an unheated enclosure in a northern state can be expected to reach sub-zero temperatures in the wintertime. A 25 motorcycle stored outside in a southern state can reach a temperature of approximately 100 degrees Fahrenheit. A black seat **102** exposed to sunlight in the Southwest can reach temperatures well over 100 degrees Fahrenheit. Accordingly, the liquid used as a heat transfer fluid must be able to accommodate these temperature extremes.

30 [0034] In one embodiment, the heat transfer fluid is a glycol liquid with a freezing point less than zero degrees Fahrenheit and a boiling temperature above

150 degrees Fahrenheit. In another embodiment, the heat transfer fluid is an inflammable liquid. In still another embodiment, the heat transfer fluid includes an anti-bacterial agent to retard biological growth in the liquid. In yet another embodiment, the heat transfer fluid has a high thermal conductivity and thermal

5 capacity.

[0035] The pump **106** must also be able to operate within the temperature constraints identified above. When the system **10** is first started, the heat transfer fluid is at a temperature within the range described above. Accordingly, in one embodiment, the pump **106** has internal mechanisms, including seals and valves, 10 that are suitable for operation at temperatures below zero degrees Fahrenheit. In another embodiment, the pump **106** is insulated, for example, with a cover of closed cell neoprene.

[0036] Figure 8 illustrates a block diagram of one embodiment of an electrical control system for the system **10**. A power supply **802** is controlled with 15 a power switch **806**. When the circuit is energized through switch **806**, the fan **808** and pump motor **810** operate. A polarity switch **812**, operated by a hot/cold switch **814**, controls the power to the thermoelectric device **816**. The thermoelectric device **816** is connected to a safety cutout device **818**, which is controlled by a temperature sensor **822**, and to a temperature controller **824**, 20 which has an operator controlled temperature selector **826** and a temperature sensor **828**, which provides feedback for the temperature controller **824**. In one embodiment, the hot/cold switch **814** and the temperature selector **826** are located on an operator panel within easy reach of the occupant of the seat **102**.

[0037] Figure 9 is a simplified schematic diagram of one embodiment of the 25 electrical control system for the system **10**. The system **10** is powered by the vehicle battery **802** and protected by a fuse **904**. In another embodiment, the battery **802** is an auxiliary battery in the vehicle. Power to the system **10** is controlled via switch **806**. In one embodiment, the switch **806** is a relay operated via a remote operator switch. After power is applied to the system **10**, the two fan 30 motors **808a** and **808b** and the pump motor **810** are energized.

[0038] A pair of polarity relays **812a** and **812b** control the polarity of the power applied to the thermoelectric devices **816a** and **816b**. Temperature selection switch **814** operates the polarity relays **812a** and **812b**, which reverses the polarity applied to the thermoelectric devices **816a** and **816b** when the polarity relays **812a** and **812b** are energized. With the polarity switch **814** in one position, the heat transfer fluid is heated, with the polarity switch **814** in the other position, the heat transfer fluid is cooled.

[0039] Series connected to the thermoelectric devices **816a** and **816b** is a contact from a cutout relay **918**, which interrupts the current through the thermoelectric devices **816a** and **816b** when the temperature exceeds specified limits. The cutout relay **918** is operated by a transistor **926** operating as a switch. In series with a bias resistor **920** is a thermistor **822**. A second resistor **924** completes the voltage divider controlling the transistor **926**. The thermistor **822** changes resistance based upon a sensed temperature, and as the thermistor **822** resistance changes the voltage applied to the base of transistor **926**, which switches when the voltage reaches a specified level. This circuit performs the function of the safety cutout device **818** and temperature sensor **822** illustrated in Figure 8. The illustrated embodiment provides for operating the cutout relay **918** when a single limit is reached. In one embodiment, the limit is an upper temperature limit and cuts out the thermoelectric devices **816a** and **816b** when the temperature exceeds an upper limit.

[0040] In one embodiment, the thermistor **822** is thermally coupled to the heat exchanger **108** and the upper limit is approximately 120 degrees Fahrenheit, which is high enough to allow heating of the seat **102** and occupant, but not so high as to cause burning or bodily harm to the occupant. In another embodiment, the thermistor **822** is monitoring the heat transfer fluid and the upper limit is approximately 110 degrees Fahrenheit.

[0041] Figure 10 is a simplified schematic diagram of another embodiment of an electrical control system for the system **10**. The circuit of Figure 10 is similar to that of Figure 9, except that the safety cutout device **818** illustrated in Figure 9 is not included in Figure 10 and the circuit of Figure 10 includes a circuit for

continuously controlling the temperature, as opposed to the circuit of Figure 9 which controls the temperature by cycling the thermoelectric devices **112** on and off. In another embodiment, the safety cutout device **818** illustrated in Figure 9 and the circuit temperature controller of Figure 10 are both utilized. In the 5 embodiment illustrated in Figure 10, a voltage divider with two fixed resistors **1020** and **1024** in series with a variable resistor **1028** feeds the gate of a metal oxide semiconductor field effect transistor (MOSFET) **1026**. The variable resistor **1028** is the temperature selector **826**. The current flow between the drain and source of the MOSFET **1026** varies with the voltage applied to the gate. By varying the 10 resistance of the variable resistor **1028**, the current flowing through the thermoelectric devices **112a** ad **112b** varies, thereby varying the heating or cooling energy transferred to the heat exchanger **108**.

[0042] Figure 11 illustrates another embodiment of a seat heating and cooling system **10'**. In one embodiment, a seat heat exchanger **1104** is adapted to fit over a seat **102**. In another embodiment, the seat heat exchanger **1104** is adapted to fit inside the seat **102**. The seat heat exchanger is part of a seat loop 15 that is connected to a heat exchanger assembly **110'** through tubing **122, 126, 132**. The heat exchanger assembly **110'** includes thermoelectric devices **112** and has a second loop that connects to an air heat exchanger **1102** through tubing 20 **1122, 1126, 1132**. The seat loop and the second loop have a fluid pumped through the loops by pumps **106, 106'**.

[0043] The seat heating and cooling system **10'** has two modes of operation: seat heating and seat cooling. With the seat **102** being heated, the thermoelectric devices **112** are powered such that the seat loop is heated. Heated fluid is pumped 25 by pump **106** through tubing **126**, circulated through the seat heat exchanger **1104**, exhausted through tubing **122** into the heat exchanger assembly **110'**, where it is re-heated. The cold side of the thermoelectric devices **112** are warmed by a fluid pumped through a second pump **106'**, through tubing **1126** into an air 30 heat exchanger **1102**, where the cold fluid is warmed, and back to the heat exchanger assembly **110'**, where it is cooled.

[0044] With the seat **102** being cooled, the thermoelectric devices **112** are powered such that the seat loop is cooled. Cooled fluid is pumped by pump **106** through tubing **126**, circulated through the seat heat exchanger **1104**, exhausted through tubing **122** into the heat exchanger assembly **110'**, where it is re-cooled.

5 The hot side of the thermoelectric devices **112** are cooled by a fluid pumped through a second pump **106'**, through tubing **1126** into an air heat exchanger **1102**, where the hot fluid is cooled, and back to the heat exchanger assembly **110'**, where it is again re-heated.

[0045] In the illustrated embodiment, the air heat exchanger, or radiator, **1102** is a fluid chamber with air cooling fins affixed to the chamber housing. In one embodiment, the radiator **1102** is mounted in an air stream created by the motion of the motorcycle, thereby transferring heat from or to the radiator **1102**. In another embodiment, the radiator **1102** is adapted to be part of the motorcycle frame with the frame serving as a heat sink, which is cooled by the ambient air.

[0046] Figure 12 illustrates one embodiment of a seat heat exchanger, or bladder, **1104** and Figure 13 illustrates a cross-section of the seat heat exchanger, or bladder, **1104**. In the illustrated embodiment, the seat heat exchanger **1104** is a bladder formed of two sheets joined at an outer seam **1212** and inside seams **1202, 1204, 1206, 1208, 1210**. The inside seams **1202, 1204, 1206, 1208, 1210**, along with the outer seam **1212**, form channels **1222, 1224, 1226, 1228, 1230, 1232** through which the heat transfer fluid flows. The heat transfer fluid from pump **106** flows through tubing **126** into inlet **1242**, through channel **1222** and then into the other channels **1224, 1226, 1228, 1230, 1232**, exiting outlet **1244** into tubing **122**.

[0047] Figure 13 illustrates a cross-section of the seat heat exchanger, or bladder, **1104** showing the two sheets **1302, 1304** separating to form channels **1228, 1226**. The pump **106**, by forcing the heat transfer fluid into the bladder **1104**, pressurizes the bladder **1104**, thereby inflating the bladder **1104** and providing a cushioned seating surface. The channels **1222, 1224, 1226, 1228, 1230, 1232** allow the heat transfer fluid to flow through every portion of the bladder **1104**, thereby preventing localized areas of a different temperature.

[0048] In one embodiment, the sheets **1302, 1304** of the bladder **1104** are made of a resilient polymer that is impervious to the heat transfer fluid. Those skilled in the art will recognize that other materials can be used to form the sheets **1302, 1304** without departing from the spirit and scope of the present invention.

5 In one embodiment, the seams **1202, 1204, 1206, 1208, 1210, 1212** are formed by welding the two sheets **1302, 1304** together.

[0049] Figure 14 illustrates an exploded view of one embodiment of the heat exchanger assembly **110'**. The illustrated embodiment of the heat exchanger assembly **110'** includes a seat side reservoir **1402**, a first gasket **1412**, a seat side channel plate **1404**, a pair of thermoelectric devices **112a, 112b**, a radiator side channel plate **1406**, a second gasket **1414**, and a heat sink plate **1408**.

[0050] The seat side reservoir **1402**, the first gasket **1412**, and the seat side channel plate **1404** are secured together by fasteners in openings **1442** that compress the parts **1402, 1412, 1404** forming fluid tight seals. The radiator side channel plate **1406**, the second gasket **1414** and the heat sink plate **1408** are secured together by fasteners in openings **1444** that compress the parts **1406, 1414, 1408** forming fluid tight seals. Another set of fasteners are disposed in openings **1512** to compress the seat side of the heat exchanger assembly **110'**, the thermoelectric devices **112a, 112b**, and the radiator side of the heat exchanger assembly **110'** and provide for heat transfer between the thermoelectric devices **112a, 112b** and the two sides of the heat exchanger assembly **110'**. Those skilled in the art will recognize that the number and placement of the openings **1442, 1444, 1512** can vary without departing from the spirit and scope of the present invention.

[0051] In one embodiment, the gaskets **1412, 1414** are formed of paper and provide a liquid-tight seal between the plates **1402, 1404** and **1406, 1408**. In another embodiment, an o-ring provides the liquid-tight between the plates **1402, 1404** and **1406, 1408**.

[0052] The seat side reservoir **1402**, the seat side channel plate **1404**, the radiator side channel plate **1406**, and the heat sink plate **1408**, in one embodiment, are fabricated of aluminum. In another embodiment, the plates

**1402, 1404, 1406, 1408** are fabricated of copper. In still another embodiment, the plates **1402, 1404, 1406, 1408** are fabricated of a material suitable for transferring heat between the heat transfer fluid and the thermoelectric devices **112**.

5 [0053] The illustrated embodiment shows two thermoelectric devices **112**; however, those skilled in the art will recognize that the number of thermoelectric devices **112** can vary without departing from the spirit and scope of the present invention. In one embodiment, the heat sink plate **1408** is attached behind a motorcycle license plate holder with the inlet port **1422** located above the 10 centerline of the seat side reservoir **1402**.

15 [0054] The first and second gaskets **1412, 1414** seal the fluid chambers between the seat side reservoir **1402** and the seat side channel plate **1404**, and between the opposing side channel plate **1406** and the heat sink plate **1408**. In one embodiment, the seat side reservoir **1402** is insulated. The insulation, in one embodiment, is a neoprene insulation, approximately 3/8 inch thick.

20 [0055] In the illustrated embodiment, for the seat side of the heat exchanger assembly **110'**, the inlet port **1422** connects to the tubing **122** from the bladder **1104** and the outlet port **1424** connects to the inlet of the pump **106** via tubing **132**. The seat side reservoir **1402** and the seat side channel plate **1404** form one heat exchanger that services the seat side fluid loop of the system **10'**. For the 25 radiator side of the heat exchanger assembly **110'**, the inlet port **1426** connects to the tubing **1122** from the radiator **1102** and the outlet port **1428** connects to the inlet of the pump **106'** via tubing **1132**. The radiator side channel plate **1406** and the heat sink plate **1408** form another heat exchanger and that heat exchanger services the radiator side fluid loop of the system **10'**.

30 [0056] Figure 15 illustrates the seat side reservoir **1402**, which has two interconnected chambers **1514, 1516** separated by a barrier **1504**. The barrier **1504** has gaps at its ends that allow the heat transfer fluid and any entrained air to flow between the two chambers **1514, 1516**. The outlet port **1424** draws heat transfer fluid from the channels in the seat side channel plate **1404**, through the opening **1432** in the gasket **1412**, from one chamber **1518**, which is separated

from chamber **1514** by a second barrier **1502**. The outlet port **1424** is oriented in the plate **1404** such that it is separated from the inlet port **1422**, thereby ensuring any entrained or trapped air in the seat side fluid system is trapped in the seat side reservoir **1402**.

5 [0057] Figure 16 illustrates the seat side channel plate **1404**, which has a series of channels formed by the barriers **1602** to **1606**, **1612** to **1618**. One group of the barriers **1602** to **1606** extend from one side of the plate **1404**, and another group of barriers **1612** to **1618** extends from the opposite side of the plate **1404**. Those skilled in the art will recognize that the number of barriers **1602** to **1606**,  
10 **1612** to **1618** forming the series of channels can vary in number and configuration without departing from the spirit and scope of the present invention.

[0058] The seat side reservoir **1402** is mated to the seat side channel plate **1404** by aligning one corner **1522** of the seat side reservoir **1402** with the corresponding corner **1622** of the seat side channel plate **1404**. With the first gasket **1412** between the plates **1402**, **1404**, a fluid-tight seal is formed between the plates **1402**, **1404**. The chambers **1514**, **1516**, **1518** face the series of channels in the channel plate **1404**, separated by the first gasket **1412**. The first gasket **1412** has an opening **1432** located adjacent the chamber **1518** whereby the heat transfer fluid flows from the seat side reservoir **1402**, through the gasket opening **1432**, through the series of channels formed by barriers **1602** to **1606**, **1612** to **1618**, and out the outlet port **1424**. The chambers **1514**, **1516** in the reservoir **1402** act as an air chamber and contain any entrained or trapped air in the seat side fluid system. An air chamber in a hydraulic system allows air to elastically compress and expand to regulate the flow of a fluid. The seat side reservoir **1402** and the seat side channel plate **1404** form a heat exchanger in which heat is transferred to/from the heat transfer fluid and the thermoelectric device **112**.  
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[0059] Figure 17 illustrates the radiator side channel plate **1406**, which has a series of channels formed by barriers **1702**, **1706**, **1712** to **1716**. Inlet port **1426** is at one end of the series of channels and outlet port **1428** is at the opposite end, thereby allowing the radiator side heat transfer fluid to flow from the inlet port  
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**1426**, through the series of channels, and out the outlet port **1428**. Those skilled in the art will recognize that the number of barriers **1702**, **1706**, **1712** to **1716** forming the series of channels can vary in number and configuration without departing from the spirit and scope of the present invention.

5     **[0060]**     Figure 18 illustrates the heat sink plate **1408**, which is a solid plate with a cutout **1410** suitable for mounting a power transistor **926** or a power MOSFET **1026**. The radiator side channel plate **1406** is mated to the heat sink plate **1408** with the second gasket **1414** between the plates **1406**, **1408** and forming a fluid-tight seal between the plates **1406**, **1408**. The radiator side channel plate **1406** and the heat sink plate **1408** form a heat exchanger in which heat is transferred to/from the heat transfer fluid and the thermoelectric device **112**.

10     **[0061]**     Figure 19 illustrates a block diagram of another embodiment of the system **10**, **10'**. In the illustrated embodiment, a power supply **802** is connected via a switch **806** to the pumps **106** and the controller **1902**. A hot/cold switch **814** toggles the polarity of the voltage applied to the thermoelectric devices **112**, thereby controlling whether the seat side fluid system is heated or cooled by the thermoelectric devices **112**. The hot/cold switch **814** is connected to a ramp function **1904**, which, in one embodiment, slowly ramps the voltage from one polarity to the other instead of abruptly changing the voltage applied to the thermoelectric devices **112**. The ramp function **1904** prevents premature failure of the thermoelectric devices **112** caused by localized heating of the conductors when the device **112** is cold. The temperature control **1906**, in one embodiment, controls the current flowing through the thermoelectric devices **112**, thereby controlling the system **10**, **10'** temperature. In another embodiment, the temperature control **1906** is not used and the thermoelectric devices **112** are driven such that they either heat or cool the seat bladder **1104**. The controller **1902** is the device that controls the power delivered to the thermoelectric device **112** based on the inputs received from the ramp function **1904** and the temperature control **1906**.

[0062] The heating and cooling system **10**, **10'** includes various functions. The function of changing a temperature of a liquid is implemented by a thermoelectric device **112** thermally coupled to, in one embodiment, a heat exchanger **108** for containing a fluid, and in another embodiment, a heat exchanger formed from a seat side reservoir **1402** mated to a seat side channel plate **1404**. The function of transferring the liquid to a heat exchanger coupled to a seat is implemented by a pump **106**.

[0063] The function of conducting thermal energy between the liquid and the seat **102** is implemented, in one embodiment, by a coil **104** coupled to the seat **102**, and in another embodiment, by a bladder **1104** having channels **1222**, **1224**, **1226**, **1228**, **1230**, **1232** through which the fluid flows.

[0064] The function of controlling a temperature of the liquid is implemented, in various embodiments, by a temperature controller **824**, **1904**. In one embodiment, the temperature controller **824**, **1904** provides power to the thermoelectric device **112**. In another embodiment, the temperature controller **824**, **1904** includes a power transistor **1026** circuit that provides for variable temperature control of the thermoelectric device **112**. In one embodiment, the temperature controller **824** includes a safety cutout device **818**. In another embodiment, the temperature controller **824** includes a temperature sensor **828**. In another embodiment, the temperature controller **824**, **1904** includes a hot/cold switch **814**. In one embodiment, the temperature controller **1904** includes a ramp function **1904**.

[0065] The function of transferring thermal energy between the structure for changing the temperature and the environment is implemented, in one embodiment, by a heat sink **114** thermally coupled to the thermoelectric device **114**. The heat sink **114**, in one embodiment, has a fan **116** forcing air across the heat sink **114**. In another embodiment, the function of transferring thermal energy is implemented by a heat exchanger formed from a radiator side channel plate **1406** mated to a heat sink plate **1408** in fluid communication with a radiator **1102**.

[0066] The function of forming an air chamber is performed by the chambers **1514, 1516** in the seat side reservoir **1402** when the seat side reservoir **1402** is mated to the seat side channel plate **1404**.

[0067] From the foregoing description, it will be recognized by those skilled in the art that a heating and cooling system for a vehicle seat has been provided. The seat relies upon conductive heat transfer between a liquid heat transfer fluid and the occupant of the seat. The conductive heat transfer is particularly suitable for exposed seats, such as on a motorcycle or tractor. In one embodiment, a heat transfer fluid transfers heat from a thermoelectric device through a heat exchanger to a fluid that is circulated through a heat exchanger, or bladder, coupled to the seat. The cold side of the thermoelectric device, in one embodiment, is air cooled by fans. In another embodiment, the cold side of the thermoelectric device is coupled to another heat exchanger in which warm fluid is circulated. The cooled fluid is pumped to a radiator, where it is warmed again. In another embodiment in which the heat flow is reversed, the heat transfer fluid transfers heat from the heat exchanger or bladder coupled to the seat to the thermoelectric device.

[0068] While the present invention has been illustrated by description of several embodiments and while the illustrative embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. The invention in its broader aspects is therefore not limited to the specific details, representative apparatus and methods, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of applicant's general inventive concept.